Design Guidelines for Width-Contracted Long-Throated Flumes

Tony Wahl and James Higgs

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Long-throated flumes are widely used for measuring open-channel flows on water resources projects. One advantage of such flumes is their adaptability, because custom designs can be created and calibrated using computer software (the WinFlume software program). In the course of studying the possibility of converting existing Parshall flumes to long-throated flumes, John Replogle of the Agricultural Research Service, Phoenix, Arizona, found that one particular configuration of long-throated flume cannot be properly rated using the existing theoretical and computer model. In flumes with short, wide control sections that are primarily width-contracted, there is a possibility that critical depth will not be reached in the control section. This causes the rating table produced by the computer software to be in error, sometimes by as much as 30 percent.

The objectives of the project were to define the conditions causing this phenomenon, and then, if possible, to develop a rule-of-thumb or other criteria that could be used to alert designers when there is potential for this problem in new flume designs.

Three-dimensional computational fluid dynamics models were created using the FLOW-3D computer software for three Parshall flumes (8-ft, 4-ft, and 2-ft wide) that had been converted to long-throated flumes using the same technique as in Replogle's first tests. Performance of these models was compared to theoretical rating curves developed using the WinFlume program. The tests showed that there was significant flow measurement error in all three cases, over the full range of operating conditions (minimum to maximum flow). On a percentage basis, the severity of the flow measurement error is greatest at low flows. The 8-ft flume exhibited the largest percentage error, which is reasonable since it has the greatest aspect ratio (ratio of control section width to control section length) and the greatest amount of width contraction of the three tested designs. Unfortunately, none of the tests produced flow at a threshold condition, i.e., the flow condition at which the error just becomes negligible. Thus, we cannot yet fully determine the exact combination of flume geometry and/or flow conditions that begins to produce the problem and cannot produce a suitable design criteria for avoiding the problem. Work on this problem is expected to continue in FY 2000 under project WR.99.24 - Water Measurement.

Water Resources Research Laboratory, Agricultural Research Service (U.S. Water Conservation Laboratory, Phoenix, Arizona)

The following paper is in progress:

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